ENVIRONMENT INDICATORS

Introduction

I. Purpose of Environment Indicators

The following twelve indicators for the environment were chosen, because they represent many of the critical environmental issues facing King County today. The presence of a healthy and intact environment is an asset to this region. Food production, timber production, tourism, and recreation depend on the integrity of natural resources such as water bodies, forests, fish and wildlife and agricultural lands. A productive economy and a high quality of life are inseparably linked to the natural environment.

The purpose of establishing indicators for the environment is to evaluate progress toward the goals and outcomes outlined in the Countywide Planning Policies. Those outcomes include the protection and enhancement of the natural environment, improvement of air quality and the protection of water quantity and quality among others. With the help of environment indicators the Growth Management Planning Council will be able to evaluate the effectiveness of the Countywide Planning Policies, monitor trends and recognize successes and potential shortfalls.

II. Key Observations

Indicator #9 **Land cover changes in urban and rural areas over time.**

- King County had the smallest percent increase in developed land area by county between 1984 and 1992 compared to Pierce, Snohomish and Kitsap counties. King County had the largest percent of its total land area developed at 11.6% in 1992 compared to the above three counties.
- Data on land cover changes was collected before the Growth Management Act began to have noticeable effects on land use patterns. Future data will present land use changes in rural and urban areas separately and may show significant changes from current land use patterns.

Indicator#10 **Air quality**

- The number of good air quality days has increased from 73 in 1980 to 343 in 1998 and the number of unhealthful days has decreased from 18 days in 1980 to no unhealthful days from 1993 to 1998.
- Many factors including increased fuel efficiency, higher emission standards and improved regulatory enforcement are responsible for the improvements in air quality. For example, newer gasoline nozzles collect more than 90% of harmful vapors, thereby helping to control air pollution.

Indicator #11 **BTU consumption per capita**

- Total energy consumption has increased 27.7% since 1986, mainly due to population and economic growth, but also due to higher per capita usage of all energy sources.
- Per capita consumption of all energy sources increased 6% from 1986 - 1993. Despite minor fluctuations over the last five years, per capita consumption in 1998 is nearly the same as it was in 1993.
- Per capita automotive gasoline consumption rose a sharp 3.6% from 1996 to 1997 after a declining trend of almost 9% from 1990 - 1996. It declined slightly from 1997 to 1998.

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- Gasoline consumption has been at an average of 44% of total energy consumption since 1986. The use of vehicles is responsible for a major part of total energy consumption, and it has the greatest single impact on air quality.

Indicator #12 **Vehicle miles traveled per year.**

- Vehicle miles traveled *per capita* have increased more than 48% between 1985 and 1998, and total vehicle miles traveled have increased by 85% in the same period. The population grew by just 24% during this time.
- There has been a 7.4% increase in VMT per capita from 1994 to 1998. The Countywide Planning Policies were adopted in 1995.
- The continued suburbanization of new population and employment has meant a higher use of motor vehicles for all travel purposes. Autos are generally the mode of choice in the suburbs.
- In 1997, the data on energy consumption showed a higher per capita use of gasoline that year compared to the previous two years. The increase in VMT per capita, low gasoline prices, and larger family vehicles may all have contributed to that rise. In 1998 gasoline consumption returned nearly to 1996 levels, most likely because of higher gasoline prices.

Indicator #13 **Surface water and groundwater quality**

- Water clarity, as measured by the *trophic state index (TSI)* in the major King County Lakes is generally high. Lake Union, however, shows some signs of declining clarity.
- Among all the monitored lakes in the region, about 35% have the lowered water clarity, more algae, and higher total phosphorus values typical of aging lakes. This is a natural process. However, deterioration over a short period of time may indicate that human activity is hastening the decline in a lake's water quality.
- Over half of King County's monitored streams are considered seriously or moderately degraded, based on the Benthic Index of Biotic Integrity (B-IBI) score.
- The biological integrity of King County streams varies between watersheds. Streams in the Cedar River Basin are in the best shape; streams in the Lake Sammamish/Issaquah Creek basin are moderately healthy with the exception of one site in Issaquah Creek; streams in the Lake Sammamish/Big Bear basin are nearly all moderately degraded; and the majority of streams in the Green River/Soos Creek basin are moderately to seriously degraded.

Indicator #14 **Water consumption**

- Water consumption per capita has decreased overall since 1985. Water consumption declined from a high of 130 gallons per capita per day in 1985 to just 106 gallons in 1997, a drop of 18%. There was a sharp drop in 1992 as a result of that year's drought. Per capita consumption rose slightly in 1998, from 106 to 109 gallons per capita,
- Total water consumption rose to 139 million gallons per day in 1998, after declining steadily from 1990- 1997.
- In 1990, Seattle Public Utilities (which serves about 75% of King County residents) started to implement some conservation measures, and in 1992, following a drought that year, more intensive measures were undertaken. These included the installation of low-flow showerheads and faucets in 65 % of households served. These and other measures have helped reduce the per capita water use.

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Indicator #16 **Change in wetland acreage and functions.**

- Tracking trends in wetland losses is complicated by several factors. Definitions and classifications of wetlands vary among jurisdictions. It is highly unlikely that wetlands will be completely inventoried. Data are not available to estimate the amount of wetlands that existed at different periods in time in order to conduct comparisons. In order to track acreage gains or losses more accurately, a representative sample of known wetlands within incorporated and unincorporated King County should be monitored over time.
- Although tracking wetland acreages is useful in order to determine net gains or losses, tracking changes in wetland functions is a more critical measure for evaluating wetland health.

Indicator #18 **Change in number of wild stock salmon.**

- There has been a long-term decline in the number of wild salmon returning to spawn to their native streams. In 1998 the listing of Puget Sound Chinook salmon as a threatened species under the Endangered Species Act (ESA) was announced.
- The average number of wild adult Chinook returning to spawn in the Lake Washington system during the 1990s has been only about one-half of the average size of runs in the 1980s. Chinook had been declining in the Snoqualmie/Snohomish basin since 1970, but in recent years there are signs of recovery. In 1998, over 6000 adult Chinook returned to that basin, the highest number since 1980.
- Wild Coho and wild Sockeye returns are also depressed, especially in the Cedar River/Lake Washington basin. In 1998 less than 500 adult Coho returned to the Lake Washington watershed.
- Strong natural fluctuations are not unusual in the number of adult Sockeye returning to the Cedar/Lake Washington watershed. However, the average for the 1990's is about 40% of what it was in the 1980's.
- It is difficult to accurately assess the number of wild salmon present in the Green River basin since a considerable number of hatchery fish may not return to the hatchery to spawn, but are intermixed with the wild stocks.

Indicator #19 **Rate of increase in noise from vehicles, planes, and yard equipment.**

- Based on its Noise Monitoring System, measures of noise level at SeaTac have decreased from an average of 71 – 73 since the early 1990's, when a mediation agreement was developed to reduce overall noise, to 68 – 70 in 1998. It appears that the noise energy has decreased even though the number of departures and arrivals has increased. This decrease can be attributed to the increase in the number of quieter Stage 3 aircraft at the airport, and the decrease in the number of noisier Stage 2 aircraft.
- Noise levels at King County International Airport have also decreased slightly over the last two years.

Indicator #20 **Pounds of waste disposed and recycled per capita.**

- The amount recycled per capita steadily increased from 1990 to 1997 at an average growth rate of 8.2%. However, the 1997 – 1998 recycling estimates for King County show a leveling off in the amount recycled per person.
- Solid waste disposal (garbage sent to land fill) per capita decreased from 1990 to 1996. As expected, it rose slightly in 1997, and leveled off in 1998.
- While the eight year trend has been toward a higher amount of waste generated per capita, 1998 actually brought a decline of two pounds per person in the amount generated when compared to the 1997 amount.

III. Discussion

Although many indicators are measured separately in this report, many linkages can be drawn among the indicators for the environment and between indicators in other sections of this report such as land use, transportation or economic development.

Air Quality

King County's air quality has improved over the last 15 years. In 1980, 20% of all days in the year were characterized as good and in 1998, 94% of all days were good air quality days. Not only does this add to the quality of life in the region, it also brings monetary benefits to residents of this county.

Better fuel efficiency, higher emission standards for industry and a large number of educational programs aimed at reducing energy consumption have contributed to better air quality. However, a rising population and an increase in the number of vehicle miles traveled (VMT) can increase the amount of pollutants released to the air. Total VMT has increased 81% between 1985 and 1997 and is likely to increase further with population growth. The use of larger, less fuel-efficient vehicles may also endanger our current achievement in improving air quality. Infrastructure and land use planning that focuses development within urban growth areas, combined with public transit options for the majority of the population, can play a significant role in helping to reduce the number of vehicle miles traveled and thus reduce impacts on air quality from vehicle emissions.

The preservation of greenbelts and forests in the vicinity of urban areas is another critical aspect of maintaining or improving air quality, because of the capacity of trees to absorb pollutants such as CO_2. In order to achieve further improvements in air quality, measures that help reduce levels of pollution in the transportation, residential, commercial and industrial sectors have to be continued and improved where appropriate.

Energy Consumption

The increase in total energy consumption over the last 12 years raises concerns for the future. While the per capita increase in energy use has been modest, total consumption continues to grow and to slightly outpace population increase. The trend during from 1995 – 1997 was toward an increasing per capita consumption. In 1998 that has leveled off again.

There was a sharp rise in gasoline consumption from 1996 - 1997 (3.6%) after a decline of almost 9% from 1990 - 1996. Lower gas prices undoubtedly contributed to this, but so did the popularity of large family vehicles requiring more gas, and the commuting needs of an expanding suburban population. Fortunately, in 1998 per capita gasoline consumption returned to its relatively low 1996 level. Gasoline represents about 44% of total per capita consumption, and thus has a strong impact on air quality.

King County Lakes and Streams

About 2/3 of King County lakes are classified as having very high or moderate water clarity (trophic status) The other 1/3 exhibit the eutrophication typical of aging lakes. Streams in King County appear to be in worse shape than its lakes, with over half of the streams classified as moderately or seriously-degraded in biological integrity. Streams in the Cedar River basin are in the best shape, while streams in the Soos Creek Basin of the Green River are the most degraded. New levels of urbanization in any of these basins could further threaten the water quality in the system's streams, and their value as aquatic habitat.

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Water Consumption

Total consumption fell from a high of 146 million gallons per day (mgd) in 1990 to 134 mgd in 1997, but rose last year to 139 mgd. Per capita water consumption in King County also rose slightly in 1998, after declining significantly for the previous 12 years. Local and regional education efforts, state and federal policies aimed at reducing per capita and total consumption, and rising water prices have all had a significant impact on reducing water consumption. However, future population and economic growth could continue to raise consumption levels in the long run. It has been observed in other regions that rising personal incomes, a trend in this region, is sometimes correlated with higher levels of residential water consumption. These trends could counteract the declining per capita rates of consumption that prevailed from 1990 – 1997.

In anticipation of the pressures of growth, Seattle Public Utilities, which serves about 75% of the residents of King County, has recently announced a substantial increase in water rates. This increase will insure that needed improvements in the system will be made and that water supply will be sufficient over next decade or more. It is expected that it will also curtail demand and lower per capita consumption.

Numerous benefits can be derived from lowering rates of water consumption. One immediate, direct effect of reduced water consumption includes lower water and sewer bills for individual households. Since a majority of the water supplying this region comes from rivers such as the Tolt which support salmon and wildlife populations, lower water consumption will keep more water in the stream to benefit salmon and other species inhabiting the stream corridor. A reduction in consumption also reduces the amount of groundwater drawn from wells which prolongs the life of aquifers and helps keep a better balance between groundwater withdrawal and its natural capacity to get recharged.

Salmon

With the listing of Puget Sound Chinook salmon as a *threatened* species under the Endangered Species Act (ESA) , monitoring the condition of salmon runs in King County has become more important than ever. The Puget Sound Basin provides habitat for a total of 209 salmon and steelhead stocks. In a 1992 assessment only about 44% of these stocks were considered healthy. The others were rated as depressed, critical, unknown, or extinct.

Even in undeveloped river systems, there are large natural fluctuations in salmon spawning and survival from year to year. These biological cycles are driven by changes in the conditions of freshwater and marine environments. However, an analysis of long term trends in the major watersheds of King County indicate that the decline in wild Chinook, Coho, and Sockeye stocks is considerably more long-lived than would be expected from natural fluctuations. For instance, through the 1970s and 1980s the number of returning Chinook adults in the Lake Washington basin fluctuated between a low of about 450 and a high of over 2000. However, 1993, 1996, and 1997 showed exceptionally low returns in the range of 250-350. Even with an increase to about 700 in 1998, the average size of runs in the 1990s are about one-half the average size of runs during the 1980s.

The number of Chinook in the Snoqualmie-Snohomish watershed showed a declining trend from the late 1970s through the mid-1990s. However, in 1998, adult Chinook returned to this watershed in their highest numbers – over 6,000 – since 1980.

A long-term downward trend is also evident among wild Coho adults which return to spawn in the Lake Washington system. In 1970, a high of 30,000 fish was recorded while a low of 200 was recorded in 1994.

After three years of relatively good returns, there were less than 500 adult Coho that returned to the Lake Washington watershed in 1998.

Despite one or two rebounds, wild Sockeye in the Cedar River basin have shown a downward trend since 1989, and are considered a depressed stock in that watershed. They are also considered a depressed stock in the Sammamish tributaries of Big Bear Creek and Issaquah Creek.

It is difficult to determine the relative importance of the each of the factors that influence the status of a particular salmon stock. There is little that can be done to affect the climatic conditions in the marine environment. Despite the natural fluctuations from year to year, many of the variations and declines in salmon populations that have been observed in the last several decades appear to be mainly the result of human impacts. In addition to the harvesting of wild salmon, habitat deterioration caused by urban and industrial growth, forest management practices, agricultural practices, municipal, industrial, and agricultural diversions, and hydropower have all contributed to diminishing the abundance and diversity of salmon.

Covering land with impermeable surfaces (e.g. building and paving) to accommodate residential, commercial and industrial growth decreases the filtration of storm and rainwater through the soil to groundwater, and increases the surface run-off to streams and lakes. The higher peaks and valleys in surface water flow can destroy spawning habitat, and cause flooding. Stormwater run-off can also carry pollutants such as automotive oil and fertilizers into surface water bodies. The cutting of shade trees, the loss of woody debris, and the creation of obstacles to the salmon's journey upstream, as well as other stream channel modifications and water diversions continue to reduce habitat quality for salmon and other aquatic life.

Salmon are an important symbol of the Pacific Northwest and provide cultural, economic, recreational and aesthetic values to residents in this region. Thus there is a strong link between habitat and salmon needs and the needs of humans. In order to restore wild salmon in King County and the rest of the state, a Wild Stock Restoration Initiative has been developed, sponsored by the Washington State Department of Fish and Wildlife and Western Washington Treaty Indian Tribes. A tri-county effort is now underway to develop a regional response to the proposed listing of Chinook, and to find ways to improve conditions for salmon survival.

IV. General Information about Indicators and Data Sources

A total of twelve indicators for the environment were chosen for inclusion into the Benchmark Report. Data is available for ten of the indicators and the remaining two will be reported in future Benchmark Reports.

There is difficulty in locating data for Indicator #15, *Change in Groundwater Levels*, because changes in groundwater levels currently are not measured in a consistent or comprehensive manner.

Data for indicators #13, *Water Quality: Groundwater* and #17 *Continuity of Terrestrial and Aquatic Habitat Networks* will be collected for future Benchmark Reports.

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Indicator #9, Data for *Land Cover Changes in Urban and Rural Areas Over Time*, including 1) percent land area that is developed; 2) acres of selected cover types; and 3) changes in distribution, will be improved as more recent data becomes available. New Landsat images should be analyzed in time for the 2000 Benchmark Report.

Data for Indicator #16, *Change in Wetland Acreage and Functions*, is incomplete for this report. Difficulty in collecting reliable and complete data is anticipated for several years in the future.

ENVIRONMENT INDICATORS

Outcome: *Protect and Enhance Natural Ecosystems*

INDICATOR 9: Land cover changes in urban and rural areas over time.

Percent of County Land Area That Was Developed as of 1984 and 1992.			
Counties	**1984**	**1992**	**Percent Change 1984 to 1992**
King	**10.4%**	**11.6%**	**12%**
Pierce	7.3%	8.6%	**18%**
Snohomish	3.3%	4.0%	**22%**
Kitsap	6.9%	8.8%	**28%**
4 County Area	7.0%	8.1%	**16.1%**

Definitions:

- *Developed land is made up of land in both urban and rural areas that has been converted from vegetative cover to low and high density developed land. The percent of developed land area may be underestimated due to Landsat's inability to distinguish between natural land cover and landscaped subdivisions, which are considered a developed, urban use.*

Observations:

- The table shows the percent of county land that had been developed by 1984 and the percent that had been developed by 1992. The last column shows the amount of new development during that period as a percent of the amount already developed in 1984.
- These data are based on an analysis of Landsat Thematic Mapper images from 1984 and 1992. A new Landsat image is being developed which will be used to update this analysis in 2000.
- Future analysis will distinguish between high intensity developed land and low intensity developed land. The former includes constructed surfaces such as buildings, parking lots and roads; the latter includes constructed surfaces (i.e. roads and buildings) surrounded by substantial amounts of vegetation.
- The data are intended to serve as a qualitative tool to determine regional changes in land cover.
- In this region, approximately 10-15 percent impervious surface area (land cover not permeable to water) in a watershed typically yields demonstrable, and probably irreversible, loss of aquatic system functions. This loss results in larger and more frequent high flows, decreased base flows to streams, and increased water level fluctuation in wetlands and small lakes. Changes in flows result in alterations to channel shape and structure which often have significant adverse impacts on plants, fish, and wildlife.
- Vegetative cover types, especially forests, provide significant ecological functions. They absorb, filter, and slow surface water flow. This is particularly important over aquifer recharge areas. Forests provide wildlife habitat, cleanse air, and are aesthetically pleasing. Fish and wildlife depend upon continuous, undisturbed habitat. When ecosystems become highly fragmented as often occurs in the process of urbanization, fish and wildlife are prevented from meeting their need for food, water, cover, and space.
- The above data were collected before the Growth Management Act began to have any effect on land use.

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Data Sources: King County Surface Water Management Department, 1996*; Remote Sensing Project Land Cover and Change Detection*, Puget Sound Regional Council, April 1994.

Policy Rationale: The policy rationale stems from Countywide Planning Policies FW-4, FW-5, CA-4, CA-7, CA-8 and CA-9. Conversion of land to urban uses (low and high density developed land) often results in the degradation and fragmentation of ecosystems.

ENVIRONMENT INDICATORS

Outcome: *Improve Air Quality*

INDICATOR 10: Air quality.

Number of Days in Each Air Quality Category by Year											
	1980	**1985**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**
Good	73	150	239	256	238	251	315	313	324	321	343
Moderate	275	202	126	109	127	114	50	52	42	44	22
Unhealthful	18	10	0	0	1	0	0	0	0	0	0
Very Unhealthful	0	0	0	0	0	0	0	0	0	0	0

Definitions:

- *The Pollutant Standards Index (PSI) provides a nationally uniform method to report daily air quality levels. The PSI reflects the maximum levels of four key pollutants: carbon monoxide, suspended particulate matter (particles 10 micrometers or less in diameter), sulfur dioxide and ozone. The concentration of each pollutant on a given day determines an Index value and the pollutant with the highest Index value determines the PSI on that day. The PSI values are then translated to a rating from "good" to "very unhealthful."*
- *The monitoring sites were chosen based on where the highest concentrations of pollutants were expected to occur. The highest values often occur in industrial areas and/or in the vicinity of heavy traffic. The majority of the monitoring sites are in urbanized areas. Since high ozone levels occur some distance downwind of Seattle, ozone levels are measured in downwind areas such as Enumclaw during the months of May through September.*

Observations:

- Air quality has improved significantly since 1980. The number of good air quality days has increased from 73 in 1980 to 343 in 1998 and the number of unhealthful days has decreased from 18 days in 1980 to no unhealthful days from 1993 to 1998.
- Many factors including increased fuel efficiency, higher emission standards and improved regulatory enforcement are responsible for the long-term improvements in air quality. As an example, many gas stations in recent years have converted to using nozzles which collect more than 90% of all the harmful vapors thereby helping to control air pollution problems. Many educational programs aimed at informing the public about ways each individual can contribute to cleaner air also have contributed to the air quality improvements evident in King County.
- Although the Puget Sound region and King County are in compliance with air quality standards, the region still is adding 1.5 million tons of pollutants into the air on a yearly basis. Motor vehicles are by far the largest contributors to overall air pollution with 55% of the total, followed by industry with 21%, outdoor burning with 12% and wood stoves and fireplaces with 12%.
- The EPA instituted a new air quality standard for ground level ozone in 1997. It is currently being challenged in the courts. However, once implemented, this tougher standard, combined with a rising population, increases in vehicle miles traveled (VMT), in truck traffic, in construction equipment usage, and in various urban activities, could result in King County being in violation of federal ozone regulations as early as next summer (2000).

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INDICATOR 10:

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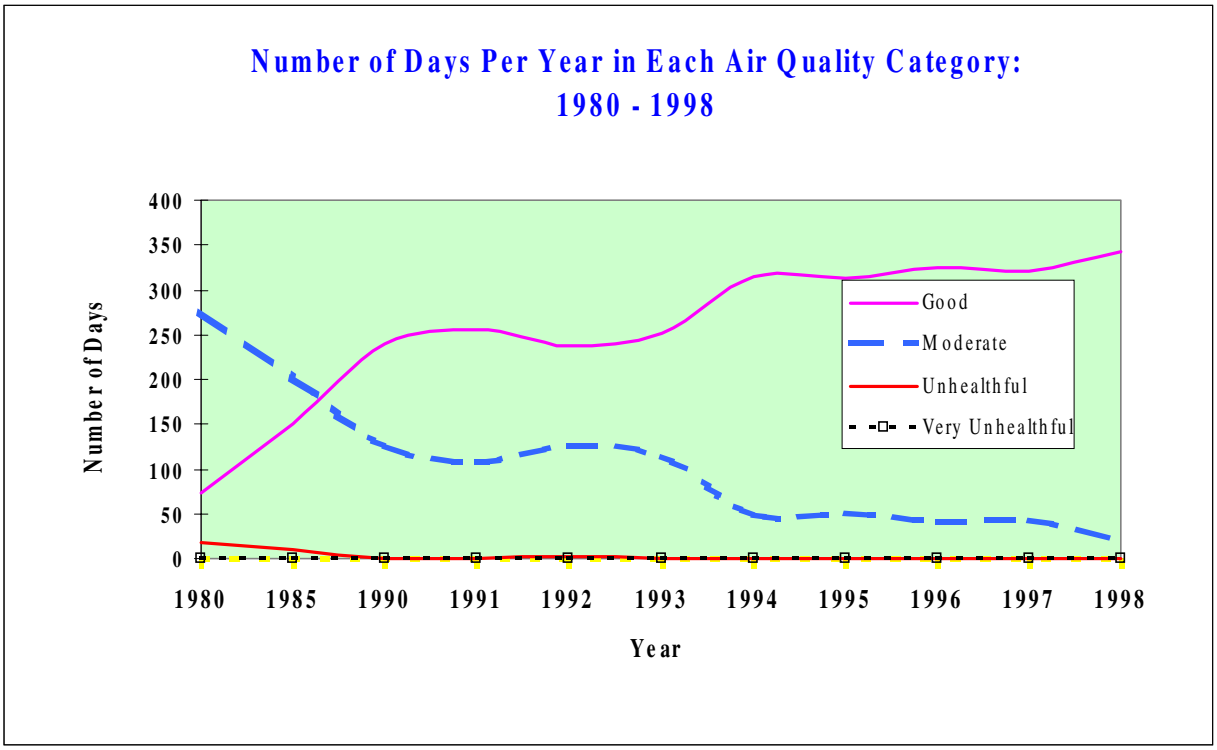
- Sports utility vehicles, minivans, and pickup trucks now exceed 50% of vehicle sales. These vehicles tend to emit pollutants at much higher levels than standard passenger cars. Current regulations allow them to produce up to three times more pollution per mile than a standard car.
- New rules, which will be phased in starting with 2004 models, will assure that the "light truck" category will have to meet the same fleetwide average pollution level as standard cars. The allowable pollution for all vehicles will be more stringent than current standards. A related rule requiring cleaner gasoline will help car manufacturers to meet the new standards.
- If the goal is to further improve or even maintain current air quality, increased efforts will have to be made to reduce the amount of pollutants reaching the air, by reducing reliance on cars, encouraging use of smaller, more fuel-efficient vehicles, reducing commute distances, and increasing availability of alternative forms of transportation.



Data Source*:* Puget Sound Air Pollution Control Agency*; Air Quality Data Summaries*, Puget Sound Air Pollution Control Agency.

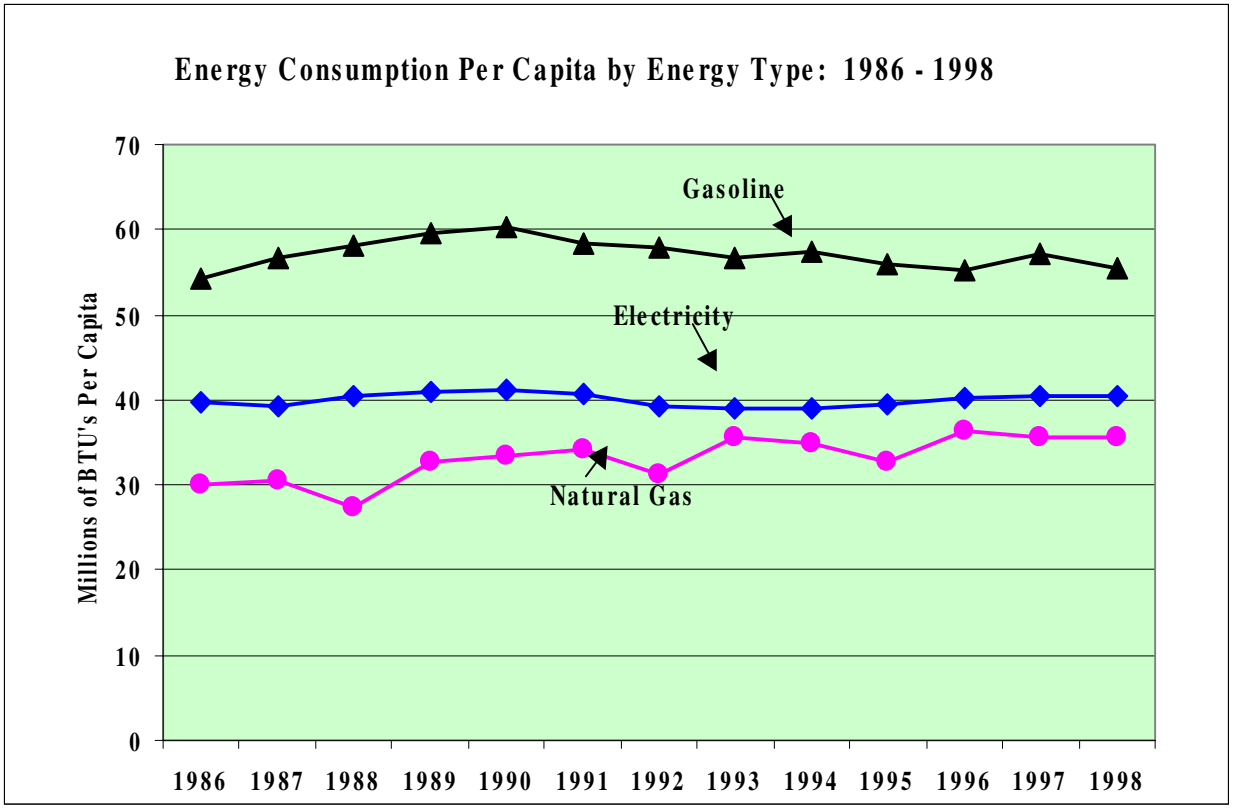
Policy Rationale: The policy rationale stems from Countywide Planning Policies FW-4 and CA-14. This Indicator focuses on maintaining air quality sufficient for public health. Measured pollutant levels during each day convert to a scale that shows if there are potential health effects. The index will register "unhealthful" when a measured pollutant level has exceeded the national primary air quality standards established to protect health. This index includes a "good" category and therefore is more sensitive than other indices which only measure the number of times an air quality standard has been exceeded.

ENVIRONMENT INDICATORS

Outcome: *Improve Air Quality*

INDICATOR 11: Energy consumption.

Energy Consumption in Million BTU's per Capita by Energy Type														
	1986	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**% Chg since 1986**
Electricity*	39.61	39.31	40.39	40.91	41.24	40.72	39.23	39.1	38.94	39.49	40.25	40.39	40.48	2.2%
Natural Gas	30.02	30.61	27.32	32.67	33.51	34.11	31.26	35.66	34.81	32.79	36.43	35.68	35.72	19.0%
Gasoline	54.35	56.63	58.15	59.6	60.28	58.44	57.78	56.69	57.51	56.01	55.15	57.17	55.51	2.1%
Diesel Fuel*						-					18.20	18.71	18.49	
Total Per Capita Energy Consumption*	123.98	126.55	125.86	133.18	135.03	133.27	128.27	131.5	131.26	128.29	131.83	133.24	131.70	6.2%
*Electricity includes both Seattle City Light and Puget Sound Energy consumption. Diesel Fuel data was only collected for 1996 - 1998. Hence it is not included in the Total Per Capita for any year.														



ENVIRONMENT INDICATORS

INDICATOR 11:

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Definitions:

- *BTU=British Thermal Unit. 3.413 Million BTU = 1 MWh*
- *Figures presented for electricity and natural gas include consumption in all sectors including residential, commercial, industrial, and government (street lights, etc). They do not include self-consumed, line loss or unbilled power.*
- *The electricity data include non-renewable and renewable sources, the former includes energy derived from coal, oil, gas and nuclear power plants and the latter from hydroelectric plants.*
- *Electricity supplied by Puget Power and Seattle City Light is generated in part in Washington State and in part in other states, Canada and Mexico. Electricity generated outside King County, if it is derived from coal or oil power plants, only affects air quality in those areas and not within the county. Electricity generated in hydropower plants impacts streams and watersheds, but does not affect air quality.*
- *50% of the natural gas supplied by Washington Natural Gas is derived from domestic sources and 50% from Canadian sources.*

Observations:

- All energy providers have been actively promoting energy conservation since the 1980's. Some have installed thermal insulation in residences and promoted energy efficient appliances.
- Per capita consumption of all energy sources has increased 6.2% since 1986. After a period of fluctuation it increased nearly 4% from 1995 to 1997, falling back a bit in 1998.
- Total energy consumption has increased 27.7% since 1986 due to population growth, economic growth, and higher per capita usage.

Natural Gas

- Per capita consumption of natural gas has increased about 19% since 1986. Total natural gas consumption has increased 44% since 1986, increasing at a much faster rate than population growth. The rise in consumption appears to be largely in the residential sector. Industrial consumption of natural gas fell 42% from 1993 - 1997.

Electricity

- Per capita electricity usage has increased 2.2% over the 12 years between 1986 and 1998. It rose slightly from 1986 - 1990, declined from 1990 - 1994, and rose again from 1994 - 1998.
- Total electricity consumption in 1998 was 24% higher than in 1986, just outpacing population growth. It appears that the rise is occurring in all sectors, with residential use increasing slightly faster in Seattle, and commercial and industrial use increasing more rapidly in areas served by Puget Sound Energy (in King County outside of Seattle).

Automotive Gasoline

- Per capita automotive gasoline consumption rose a sharp 3.6% from 1996 to 1997 after a declining trend of almost 9% from 1990 - 1996. It declined slightly from 1997 – 1998. Over the 12 years from 1986 - 1998, per capita gasoline use has risen 5.2%. This may reflect the use of larger vehicles (minivans, sports utilities vehicles and light trucks) as well as lower gasoline prices and an increase in vehicle miles traveled per person.
- Total automotive gasoline consumption has risen 24% from 1986 – 1998. As with electricity consumption this is slightly higher than the rate of population growth.

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INDICATOR 11:

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- Gasoline consumption has been at an average of 44% of total energy consumption since 1986. The use of vehicles is responsible for a significant part of total energy consumption and air quality effects.
- Diesel fuel usage per capita also rose nearly 3% from 1996 – 1997 but fell again in 1998.

Data Sources: Seattle City Light, 1998; Puget Power, 1998; Washington Natural Gas, 1998; Puget Sound Energy, 1998. Washington State Department of Transportation, 1998.

Policy Rationale: The policy rationale stems from Countywide Planning Policies ED-11, CO-2, CO-3 and CO-6. Most uses of energy have direct and indirect environmental impacts, which can include deterioration of air quality, water quality and natural resources. Public health can also be negatively impacted as a result of energy production and use. Energy conservation is critical for the protection of the region's environment and to postpone the need for the construction of new and expensive energy-producing facilities.

ENVIRONMENT INDICATORS

Outcome: *Improve Air Quality*

INDICATOR 12: Vehicle miles traveled (VMT) per year.

Vehicle Miles Traveled										
Year	**1985**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**
Vehicle Miles Traveled per Capita	6,344	8,933	9,329	9,846	8,720	8,771	9,318	9,114	9,357	9,422
Total VMT Traveled (in billions)	8.5	13.5	14.4	15.4	13.8	14.0	15.0	14.8	15.4	15.7

Definitions:

- *Vehicle Miles Traveled (VMT) is a measure of the total miles traveled by all vehicles on the road in a given year for a given period of time. Vehicle Miles Traveled per Year is based on approximate total miles traveled as reported in the "Highway Performance Monitoring Report", (HPMS) Washington State Department of Transportation. The data are based on a sample of actual highway mileage with expansion factors used for rural, small urban, and urbanized areas to arrive at totals. HPMS is not designed for use at the local jurisdictional level, but rather for use in determining the needs for roadways at the State level. The large increase in VMT between 1985 and 1990 shown in the table is based on sampling and expansion factors that were not designed to be aggregated at the County level. When thus aggregated, the figures overstate the increase in VMT between 1985 and 1990.*

Observations:

- Motor vehicles are the major source of carbon monoxide and hydrocarbon air pollutants. Regional air quality has improved over the last several years. At the same time, county annual VMT per capita has risen over 48% from 1985 to 1998. Factors such as auto fuel efficiency and the availability of oxygenated gasoline in the wintertime account for improve air quality through 1998.
- The 48% increase in this Indicator from 1985 to 1998 is caused by a combination of factors, including county growth in population and employment, lower density suburban growth, increased propensity to travel, and stable to lower gasoline prices. The result has been more vehicles on the road, traveling more miles per capita, but until recently, burning less gasoline per mile because of higher fuel efficiency. (See Indicator #11)
- While vehicle miles traveled *per capita* in King County has increased 48% between 1985 and 1998, *total* vehicle miles traveled has increased by 85% while the population grew by 24%.
- The annual VMT per capita Indicator includes a sector of the population that does not drive (the age zero to 16 group). More detailed analysis is needed to relate the VMT figures to the population increase in those of driving age.

ENVIRONMENT INDICATORS

INDICATOR 12:

(continued from previous page)

Observations: (continued)

- Fuel consumption and gas tax collection are only partially correlated with VMT. Fuel efficiency on some vehicles has increased over the 1985 to 1998 time period, meaning that it is possible to drive more miles with no more fuel being consumed. With this greater fuel efficiency, the increase in tax revenues has been less than the increase in miles traveled. However, the recent popularity of larger vehicles may be reversing the trend toward less fuel consumption per mile and per capita.
- The continued suburbanization of new population and employment in the county can mean a higher use of motor vehicles for all travel purposes. Autos are generally the mode of choice in the suburbs. By encouraging new development within urban growth areas, close to employment, and particularly within urban centers, the GMA and CPP's intend to decrease the need for motor vehicle travel, and to make alternative modes of transportation more accessible.

Data Source: *Highway Performance Monitoring Report 1981-1998*, Washington State Department of Transportation.

Policy Rationale: The policy rationale stems from Countywide Planning Policies T-8, CA-14 and CA-15. In 1994, the most common mode of travel in King County was the Single Occupancy Vehicle (SOV). Studies show that automobile traffic also significantly impacts water quality through runoff. The primary contributor to air pollution in the County, by an enormous margin, is the SOV. Lessening SOV travel, as measured by reductions in VMT, is essential for protecting the environment of our region. VMT is a general measure of travel demand that is used for both air quality management and Transportation Demand Management.

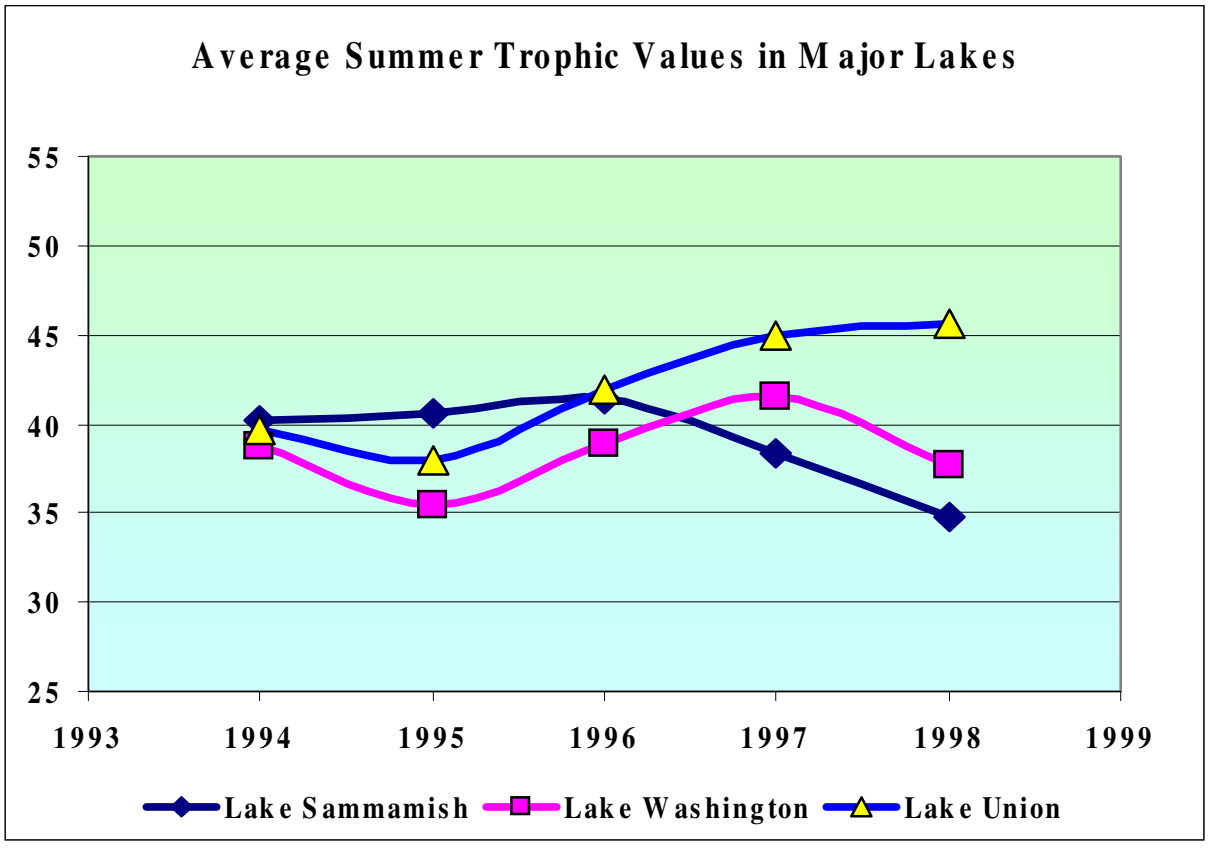
ENVIRONMENT INDICATORS

Outcome: *Protect Water Quality and Quantity*

INDICATOR 13: Surface water and groundwater quality.

A. King County Lakes

Major King County Lakes						
	Average Summer Trophic Index Values					Classification
Lake	**1994**	**1995**	**1996**	**1997**	**1998**	
Sammamish	40	41	41	38	35	Oligotrophic
Washington	39	35	39	41	38	Oligotrophic
Union	40	38	42	45	45	Mesotrophic



ENVIRONMENT INDICATORS

INDICATOR 13:

(continued from previous page)

Level II Monitored King County Lakes					
	Trophic Values				Classification
	1996	1997	1998	94 - '98 Average	
Angle	-	36	35	37	Oligotrophic
Lucerne	38	40	34	39	Oligotrophic
Meridian	-	40	38	39	Oligotrophic
Pipe	40	41	36	40	Oligotrophic
Ravensdale	40	41	39	40	Oligotrophic
Retreat	39	40	35	38	Oligotrophic
Star	38	42	39	39	Oligotrophic
Beaver 2	46	48	49	47	Mesotrophic
Bitter	-	48	43	46	Mesotrophic
Boren	-	47	45	46	Mesotrophic
Burien			42	42	Mesotrophic
Geneva	42	44	40	42	Mesotrophic
Haller	-	47	44	45	Mesotrophic
Kathleen	49	50	49	49	Mesotrophic
Leota	-	-	46	46	Mesotrophic
Mirror	-	48	46	47	Mesotrophic
Morton	43	43	40	43	Mesotrophic
Neilson	45	47	43	45	Mesotrophic
North	43	52	43	45	Mesotrophic
Pine	41	40	39	41	Mesotrophic
Sawyer	42	43	40	43	Mesotrophic
Shadow	-	44	45	45	Mesotrophic
Shady	43	42	36	41	Mesotrophic
Spring	44	51	43	46	Mesotrophic
Steel	43	47	45	45	Mesotrophic
Twelve	45	-	39	45	Mesotrophic
Wilderness	44	45	40	44	Mesotrophic
Beaver 1	-	56	52	54	Eutrophic
Cottage	54	52	48	52	Eutrophic
Desire	56	56	52	54	Eutrophic
Dolloff	60	59	57	57	Eutrophic
Fivemile	53	52	51	52	Eutrophic
Francis	50	49	53	51	Eutrophic
Garrett	60	59	59	59	Eutrophic
Killarney	51	53	53	51	Eutrophic
McDonald	55	55	55	55	Eutrophic
Paradise	52	56	52	53	Eutrophic
Trout	54	56	53	54	Eutrophic
Webster	54	50	-	52	Eutrophic
Welcome	52	48	50	50	Eutrophic
Allen	64	67	63	65	Hypereutrophic
Panther-Kent	60	67	-	-	Hypereutrophic

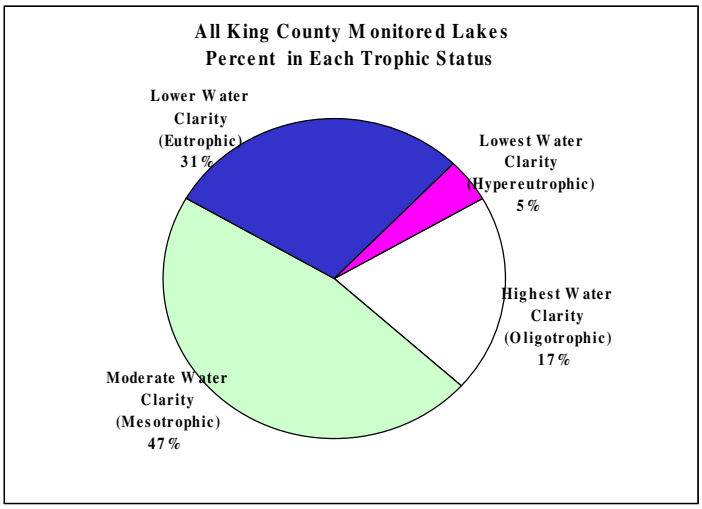
ENVIRONMENT INDICATORS

INDICATOR 13:

(continued from previous page)

Definitions:

- *Eutrophication refers to the biological activity in a lake, reflecting the natural aging process. Lakes age over time and gradually fill in, becoming ponds, marshes, wetlands and eventually forests. Measuring lake eutrophication is one of the most common ways to assess lake health.*
- *Carson's (1977)* **trophic state index (TSI)** *is a method of quantifying this eutrophication on a scale of 0 - 100. The index integrates water clarity, total phosphorus, and algae measurements into a single value.*
- *Lakes with values around 40 or less (oligotrophic) have high water clarity, lower algae values, and lower total phosphorus values.*
- *Lakes with TSI values between 40 and 50 (mesotrophic) have moderately good water clarity, algae and phosphorus values.*
- *Lakes represented by TSI values between 50 and 60 (eutrophic) typically have poorer summer water quality including lower water clarity, higher chlorophyll a values and higher total phosphorus values.*
- *Hypereutrophic lakes have TSI values greater than 60 and are very biologically productive. They have wetland-type attributes.*
- *The TSI values are a continuum and hence some lakes may be in a borderline range, exhibiting some qualities of upper and lower classifications.*



Observations:

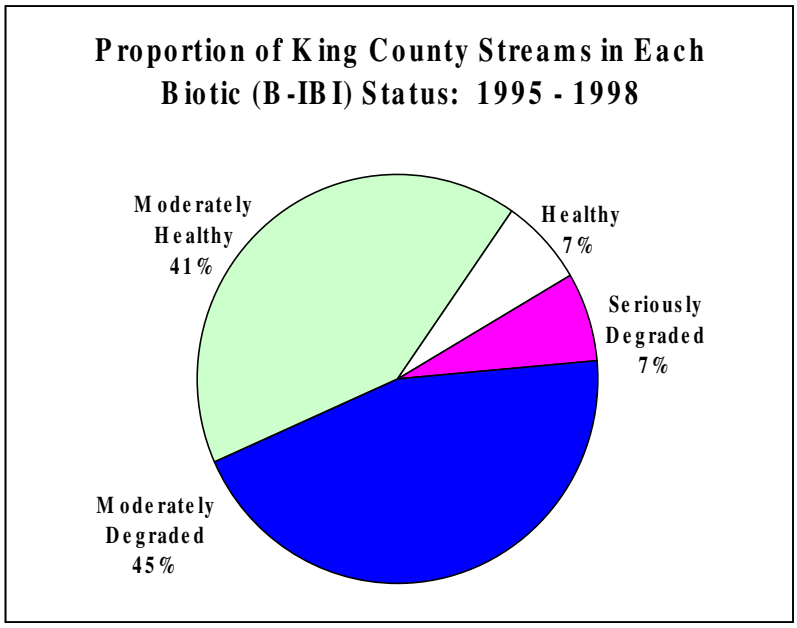
- Factors that influence water quality vary significantly from lake to lake. Generally it is more useful to look at changes in a lake's water quality over time to assess the health of the lake. Comparing water quality among a group of lakes is also a useful evaluation method.
- Nine of the monitored lakes in King County are classified as oligotrophic. About one half of the lakes have TSI values between 40 and 50, classifying them as "mesotrophic" in water quality. (See table above) Two lakes (Allen and Panther-Kent) are classified as hypereutrophic. For lakes where data has been collected over several years, TSI values are fairly consistent and have generally remained in the same trophic state classification. This indicates stable lake health. Only in four lakes (Union, Spring, North, and Panther-Kent) has there been enough change in TSI over several years to warrant a change or potential change in classification.
- Lake Union's trophic status was in the oligotrophic range from 1994 - 1995. However, its TSI values of 45 in 1997 and 1998 indicate that its water quality has declined. It is now classified as mesotrophic.

ENVIRONMENT INDICATORS

INDICATOR 13:

(continued from previous page)

B. King County Streams



Definitions:

- *The Benthic Index of Biotic Integrity (B-IBI) is a "report card" for the biological integrity of aquatic systems. Biological integrity is defined as "the ability to support and maintain a balanced, integrated, adaptive biological system having the full range of elements and processes expected in the natural habitat of a region" (Karr et al., 1996)*
- *The King County Water and Land Resources Division employs the B-IBI to determine the health of King County streams. The B-IBI evaluates the health of a stream by measuring the quantity of certain aquatic macroinvertebrates present in a stream sample. The number and condition of these macroinvertebrates yield 10 measures, each of which is assigned a score from 1 (severe degradation) to 5 (little or no degradation). The total score thus ranges from 10 (severe degradation by all measures) to 50 (little or no degradation by all measures).*
- *B-IBI scores for streams in four King County Basins are given in the table below. The graph above shows the percent of King County streams judged to be in each category based on their B-IBI score. Streams with values in the 41 – 50 range are considered to be "healthy", in the 31 – 40 range they are called "moderately healthy", in the 21 – 30 range they are termed "moderately degraded", and in the 10 –20 range they are designated as "severely degraded".*

Observations:

- Average scores from King County streams range from 14 (Little Soos Creek) to 44 (Lower Rock Creek). Most sites have only one or two years' worth of data. Biomonitoring data are most valuable when repeated sampling is performed to establish trends. This current monitoring program has not established sufficient data for analysis of long term trends.
- As the graph above illustrates, over half of the monitored King County streams are designated seriously or moderately degraded based on the B-IBI score. Streams in the Snoqualmie Basin are currently not included in this monitoring effort.

ENVIRONMENT INDICATORS

INDICATOR 13:

(continued from previous page)

Lake Washington/Lower Cedar River Basin

- There is a notable difference in the biological integrity of the streams from one basin to the next. In broad terms the streams in Cedar River Basin are in the best shape - healthy or moderately healthy. The Cedar River flows into the south end of Lake Washington. The Cedar River and its tributaries contain much of the best remaining aquatic habitat in the Lake Washington system, although over half of the historic fish habitat has been lost or degraded.
- The water quality of Lake Washington is largely dependent upon the high quality of the water from the Cedar River and upon the control of pollutants that enter the lake from other drainages. However, a significant amount of new development in the basin could threaten the system's water quality.

Lake Sammamish/Issaquah Creek and Big Bear Creek Basins

- Streams in the Issaquah Creek watershed are moderately healthy, except for one site at Holder Creek which is moderately to seriously degraded. Issaquah Creek empties into the south end of Lake Sammamish.
- Big Bear Creek flows into the Sammamish River just above the north end of Lake Sammamish. Streams in this basin are moderately to seriously degraded, with the exception of Lower Mid Bear. Water quality and fish habitat are in decline or threatened throughout the Samammish watershed. Many streams that supported substantial runs of salmonids one or two decades ago now support far fewer of these fish. The watershed contains a mix of land uses that include urban areas, agriculture, numerous parks, and forest production zones. Approximately 50% of the watershed is within the Urban Growth Boundary.

Green River/Soos Creek Basin

- Five out of eight monitored streams in the Middle Green River Sub-Watershed are seriously to moderately degraded. While it is one of the largest remaining agricultural communities in King County, it is increasingly in demand as an affordable area for suburban and rural residences. Although the stream systems continue to support significant fish habitat, the urban designation of parts of these streams could lead to further degradation in water quality, stream flow, and habitat.

Data Source: King County Department of Natural Resources, Water and Land Resources Division, 1998. An Atlas of the Watersheds of King County, Washington, 1995.

Policy Rationale: The policy rationale stems from Countywide Planning Policies CA-5 and CA-6. The preservation of surface water quality is critical, because approximately 80% of the drinking water supplying this region comes from rivers such as the Tolt and the Cedar. Salmon and other aquatic life also require high quality water for their healthy development and survival. Groundwater quality is an important regional issue because groundwater provides approximately 20-30% percent of the water used in King County for private, municipal, industrial, and agricultural needs, and aquifers cross jurisdictional boundaries. In the future, groundwater may provide an even greater percentage of our water supply needs.

ENVIRONMENT INDICATORS

INDICATOR 13:

(continued from previous page)

Biotic Integrity (B-BIBI) Scores for Streams in Four King County Basins

Basin	Biomonitoring Site	1995	1996	1997	1998	Average for Years with Data	Status by Average B-IBI
Green River							
	Little Soos Creek	14		14		14	Seriously Degraded
	Upper Soos Creek	20		20		20	Seriously Degraded
	Upper Jenkins				22	22	Moderately Degraded
	Lower Soos Creek	28		28		28	Moderately Degraded
	Lower Jenkins	30		28	30	29	Moderately Degraded
	Lower Covington Creek	34		30		32	Moderately Healthy
	Upper Covington Creek	*		32		32	Moderately Healthy
	Lower Soosette Creek	36			34	35	Moderately Healthy
Big Bear Creek							
	Lower Bear (mouth)	22			20	21	Moderately Degraded
	Mid Evans	*	26	24	18	23	Moderately Degraded
	Upper Bear Creek	26				26	Moderately Degraded
	Mackey Creek	26			32	29	Moderately Degraded
	Cottage Lake Creek	36	28	26		30	Moderately Degraded
	Trib 0111A	*		30		30	Moderately Degraded
	Low Mid Bear (133rd)	34	*	28		31	Moderately Healthy
Issaquah Creek							
	Holder Creek			28	32	30	Moderately Degraded
	Issaquah Creek @ KC park across fro		30		32	31	Moderately Healthy
	North Fork Issaquah Creek		28		34	31	Moderately Healthy
	Issaquah Creek @ 56th St.	36	28		34	33	Moderately Healthy
	East Fork Issaquah Creek		30		36	33	Moderately Healthy
	Issaquah Creek @ 165th	32			36	34	Moderately Healthy
	Carey Creek @ Iss-Hobart I	36	34		40	37	Moderately Healthy
	Black Nugget Creek		46		42	44	Healthy
Cedar River							
	Upper Lower Peterson Creek		24		26	25	Moderately Degraded
	Lower Walsh Creek		26		28	27	Moderately Degraded
	Lower Lower Peterson Creek		28		26	27	Moderately Degraded
	Taylor Creek		30		34	32	Moderately Healthy
	Upper Rock Creek		32		40	36	Moderately Healthy
	Lower Rock Creek		38	46	48	44	Healthy

* Indicates that scores could not be calculated.

Watersheds, Rivers and Major Streams

ENVIRONMENT INDICATORS

Outcome: *Protect Water Quality and Quantity*

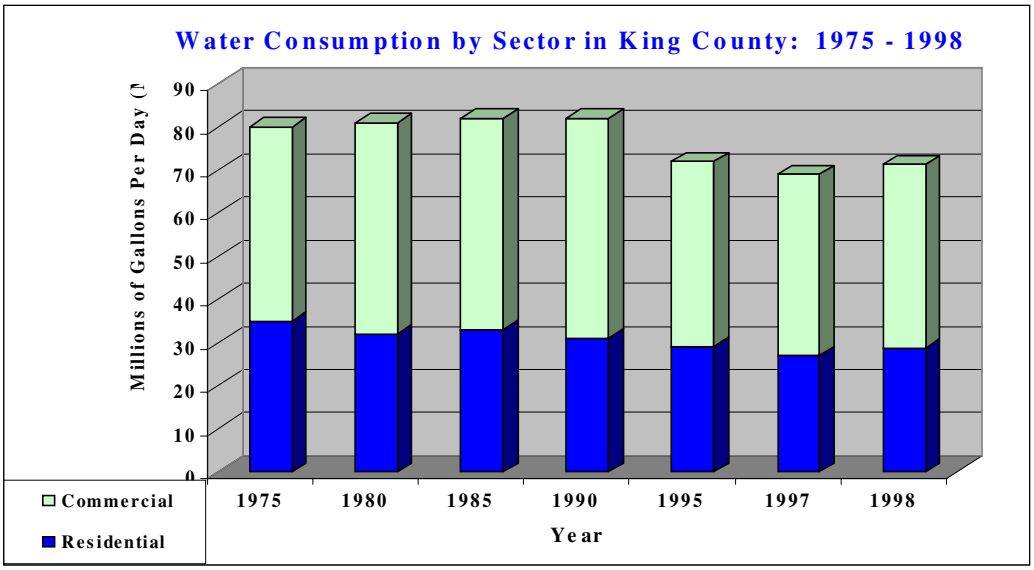
INDICATOR 14. Water consumption.

Billed Water Consumption Per Day								
Year	**1975**	**1980**	**1985**	**1990**	**1995**	**1996**	**1997**	**1998**
Consumption per Capita in Gallons*	123	124	130	122	110	109	106	109
Total Consumption in Millions of Gallons	120	130	143	146	138	137	134	139

*Seattle Public Utilities serves about 75% of King County residents. The per capita figures refer to the population served by SPU.

Definitions*:*

- *The Seattle Public Utilities (SPU) supplies water, primarily from the Tolt and Cedar River watersheds, to about 76% of King County residents. This includes water that is sold wholesale to hundreds of smaller water purveyors that serve outlying areas of the County. Edmonds and Olympic View receive some of their water directly from SPU, although they are both outside King County. Water District 83, Redmond and Highline are also within the SPU service area, but have other sources of supply. Water from other sources amounts to about 7 million gallons per day which are not included in the table above or the graph below.*
- *The table represents total billed water consumption per capita and total billed consumption sold both retail and wholesale by SPU, which also includes purveyor non-revenue water. Billed consumption does not include unmetered (non-revenue) water such as main and reservoir flushing, leaks, etc.*
- *The graph below represents billed consumption in million gallons per day by residential and commercial customers. It differs from the table because it does not include wholesale water consumption.*



ENVIRONMENT INDICATORS

INDICATOR 14:

(continued from previous page)

Observations:

- Water consumption per capita has decreased overall since 1985. The 1992 drought brought about a dramatic drop in water consumption. Although per capita consumption rose slightly in 1994, it declined steadily from 1995 - 1997. In 1998 per capita water consumption returned to the slightly higher 1996 level, primarily because of dry summer weather. Water consumption per capita is notably lower this decade than in the 1980's when it showed an upward trend.
- The drought of 1992 forced the SPU to curtail water supply. In 1990, it implemented some conservation measures and in 1992, initiated more intensive measures. Those included the installation of low-flow showerheads and faucets in 65% of households served. This and other measures also helped reduce the per capita water use. Only 101 gallons per capita were used in 1992.
- 1993 also had a very low consumption rate with 103 gallons per capita per day. The summer of 1993 was marked by cold and rainy weather which reduced water consumption. That year, the state passed plumbing codes that required the sale of low-flush toilets (1.6 gallons per flush) and set maximum flows for showerheads. These measures should reduce water consumption in the long term.
- Total water consumption showed an upward trend until 1990. From 1990-1995 there was an overall downward trend despite a growing population. Since 1995 total consumption has leveled off.
- The graph displaying water consumption by customer class shows that residential consumption has declined slightly during the 1990s compared to 1980 levels. It represented about 44% of consumption in 1975 and about 40% in 1998. The graph does not include wholesale consumption.
- Commercial consumption reached a high of 51 million gallons per day in 1990 and has declined steadily to 42 million gallons per day in 1997. In 1998, commercial consumption remained almost the same as in 1997 at 42.5 mgd.
- Wholesale consumption has risen steadily during the 1980s and 1990s. This is primarily due to population and employment growth in the suburban and rural wholesale service areas.

Data Source: Seattle Public Utilities, 1998.

Policy Rationale: The policy rationale stems from Countywide Planning Policies CO-4, CO-5, CO-6 and CO-7. Adequate long- and short-term water supplies are critical for our region's residential, commercial and industrial uses. Water conservation measures including the use of efficient plumbing devices and native landscaping are being promoted in order to ensure long-term supply and to reduce costs of finding and developing additional water sources. Conservation also helps to protect fisheries and wildlife by allowing adequate in-stream flows in rivers and streams. Regional coordination and the protection of watersheds are essential elements in enhancing and promoting the economic and environmental integrity of this area.

ENVIRONMENT INDICATORS

Outcome: *Protect Water Quality*

INDICATOR 15: Change in groundwater levels.

Data for this indicator will be available in the future.

Policy Rationale: The policy rationale stems from Countywide Planning Policies CA-5 and CA-15. This Indicator alerts officials and citizens of the need to monitor groundwater quantity to assure sustainability and prevent depletion. Groundwater supplies approximately 20-30% percent of the water used in King County for private, municipal, industrial and agricultural needs, and increasing amounts of groundwater are being withdrawn to meet human needs. A finite amount of precipitation is available to replenish groundwater supplies. As the area of impervious surfaces increases, a larger percentage of water flows into surface water bodies and therefore is no longer available to percolate through soil and recharge groundwater. Aside from human needs some of the groundwater supply is needed to provide base flows to sustain fish and wildlife habitat.

ENVIRONMENT INDICATORS

Outcome: *Protect Wetlands*

INDICATOR 16: Change in wetland acreage and functions.

The following data sheets should serve as background information on the study of wetland acreage and functions only. Due to incomplete data, no clear outcomes can be inferred.

Acreage and Number of Inventoried Wetlands in King County by Wetland Class in 1990

Classes	# of Wetlands	Acreage
Class 1	189	8,730
Class 2	592	8,666
Class 3	105	71
Total	886	17,467

Definitions:

- *The above table represents acreage of only those wetlands that have been inventoried within unincorporated King County west of the forest production district. Some wetlands from Lake Forest Park and Woodinville are also included.*
- *King County also has data for an additional 497 wetlands with an acreage of 3,300 from other sources, the main one being the National Wetlands Inventory. However, those data have not been field-verified by King County staff.*
- *The 1983 King County Wetlands Inventory classified wetlands within unincorporated King County into classes 1, 2 and 3 with class 1 being unique or outstanding, class 2 being significant and class 3 being of lesser concern. The criteria used to classify wetlands include size, presence of threatened or endangered species, percentage of area permanently covered by open water and number of vegetation classes. Wetland classes are defined in King County Code 21A. 06.1415.*

Observations:

- Tracking trends in wetland losses is complicated by several factors. Definitions and classifications of wetlands vary among jurisdictions. The current inventories are incomplete and data are not available to estimate the amount of wetlands that existed at different periods in time compared to today. Although some jurisdictions in King County have wetland inventories, none of the jurisdictions contacted track wetland acreage losses over time.
- The above table represents acreage of only those wetlands that have been inventoried within unincorporated King County. As more wetlands are inventoried, acreage will be added to the total listed above. It is expected that most of the wetlands that will be inventoried in the future will belong to classes 2 and 3. In order to track acreage gains or losses more accurately, a representative sample of known wetlands within incorporated and unincorporated King County should be monitored over time.
- Although tracking wetland acreages is useful in order to determine net gains or losses, tracking changes in wetland functions over time is a more important and a more critical measure for evaluating wetland health.

ENVIRONMENT INDICATORS

INDICATOR 16:

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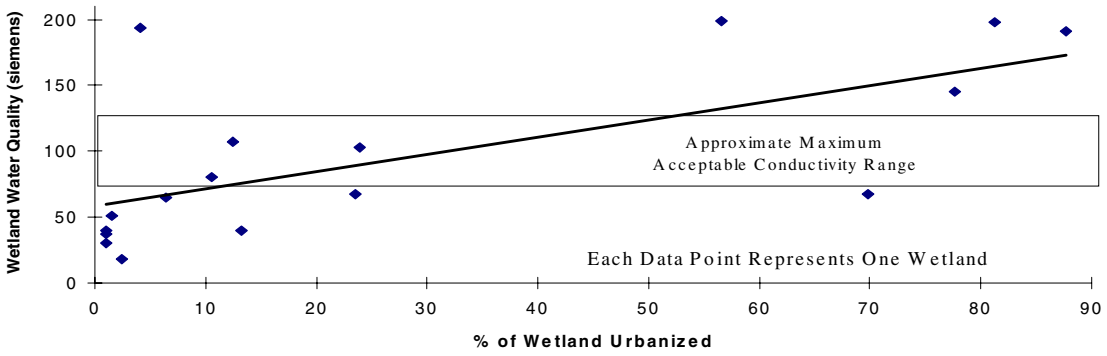
Chart #1: Wetland Water Quality vs Urbanization



Definitions:

- *The data incorporated in charts 1, 2 and 3 were generated in a seven-year study conducted as part of the Puget Sound Wetlands and Stormwater Management Research Program (PSWSMRP), and represent 19 wetlands within unincorporated King County. Since 1987, several areas containing monitored wetlands have been incorporated. The three graphs are presented to give an ecological evaluation of wetlands: water quality vs. urbanization; water level fluctuation vs. urbanization; and amphibian richness vs. water level fluctuation. These factors may not give a comprehensive evaluation of wetlands quality, but they do provide critical information on the effects of urbanization and changes in the watershed on wetland's quality, and can be used as base information for future benchmark studies.*

Observations:

- Wetlands tend to function best within a specific water quality range; deviations from this norm can present a problem to the wetland system's health. In the first chart, water quality (shown in siemens, a measure of electrical conductivity) is plotted against the percentage of urbanized wetland.
- The data show that with increased urbanization wetlands are more likely to exhibit lower water quality and that a low level of urbanization tends to preserve water quality. The level of urbanization is measured by the area that changed from primary or secondary "natural" growth to developed land such as lawns, dirt roads, buildings, paved roads, parking lots, etc.

ENVIRONMENT INDICATORS

INDICATOR 16:.

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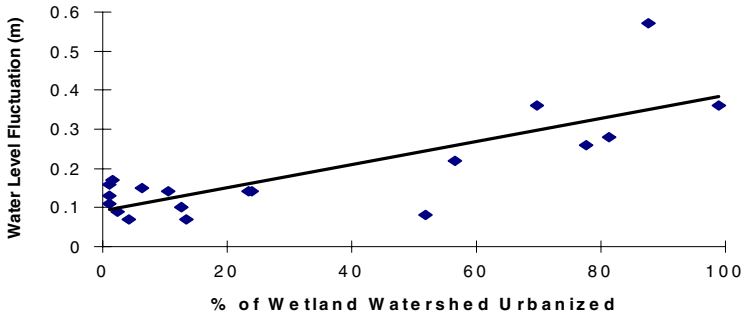
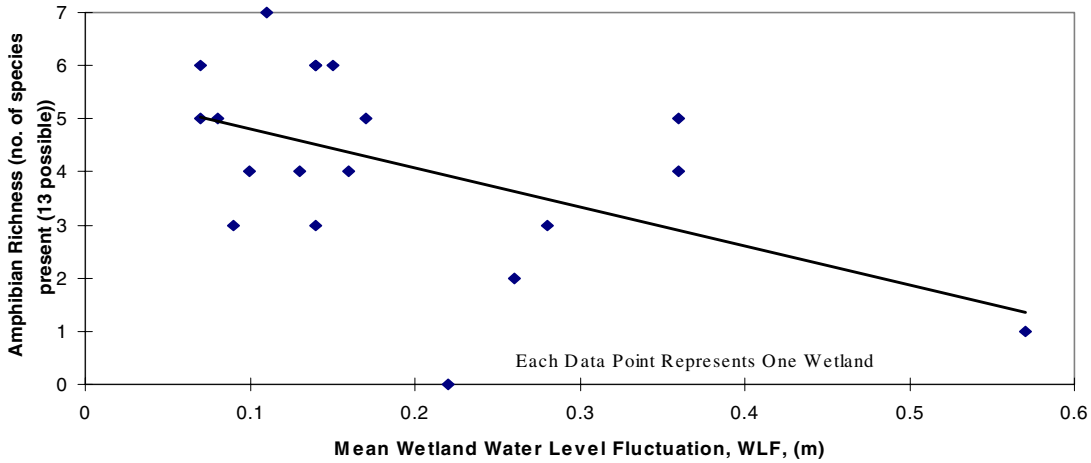
Chart#2: Mean Wetland Water Level Fluctuation vs Urbanization



Observations:

- Chart #2 shows water level fluctuation, the difference between high and low levels measured on an instantaneous basis, versus percentage of wetland urbanization. Wetlands plant and animal communities have evolved to function optimally within relatively stable water levels of healthy wetlands.
- The data show that wetlands exhibit greater water level fluctuation and thus fluctuation outside their normal range with increasing urbanization. Such changes can disrupt wetland systems and cause the decline of existing animal and plant communities.

Chart #3: Amphibian Richness vs Wetland Water Level Fluctuation



ENVIRONMENT INDICATORS

INDICATOR 16:.

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Observations:

- Chart #3 shows that amphibian richness is greater in wetlands exhibiting low water level fluctuations. Amphibians may be adversely affected by high water level fluctuations, because they can reduce spawning, egg-laying and survival of larvae.
- Since increased urbanization results in higher water level fluctuations, amphibians are directly affected by increasing urbanization. Aside from water level fluctuations, amphibians may also be affected by poor water quality, habitat loss, fragmentation of habitat and predation.

Data Sources: *Indicators of Community Sustainability,* Sustainable Seattle 1995; Puget Sound Wetlands and Stormwater Management Research Program scientists provided the data to Sustainable Seattle; Department of Development and Environmental Services GIS; 1996; National Wetlands Inventory, 1996.

Policy Rationale: The policy rationale stems from Countywide Planning Policy CA-3. Wetlands are valued highly for many of the functions they provide. Those include habitat, stormwater control, groundwater recharge, water quality protection and open space. Wetlands are biologically highly productive ecosystems and are essential to a vast diversity of species, including birds, fish, reptiles, invertebrates and mammals for feeding, nesting, cover and breeding. At least 1/3 of Washington State's threatened and endangered species require wetlands for their survival. This Indicator is designed to evaluate whether the policy of "no net loss" of wetland functions and acreage is being achieved. In the long term, the quantity and quality of wetlands should be increased.

ENVIRONMENT INDICATORS

Outcome: *Protect the Diversity of Plants and Wildlife*

INDICATOR 17: Continuity of terrestrial and aquatic habitat networks.

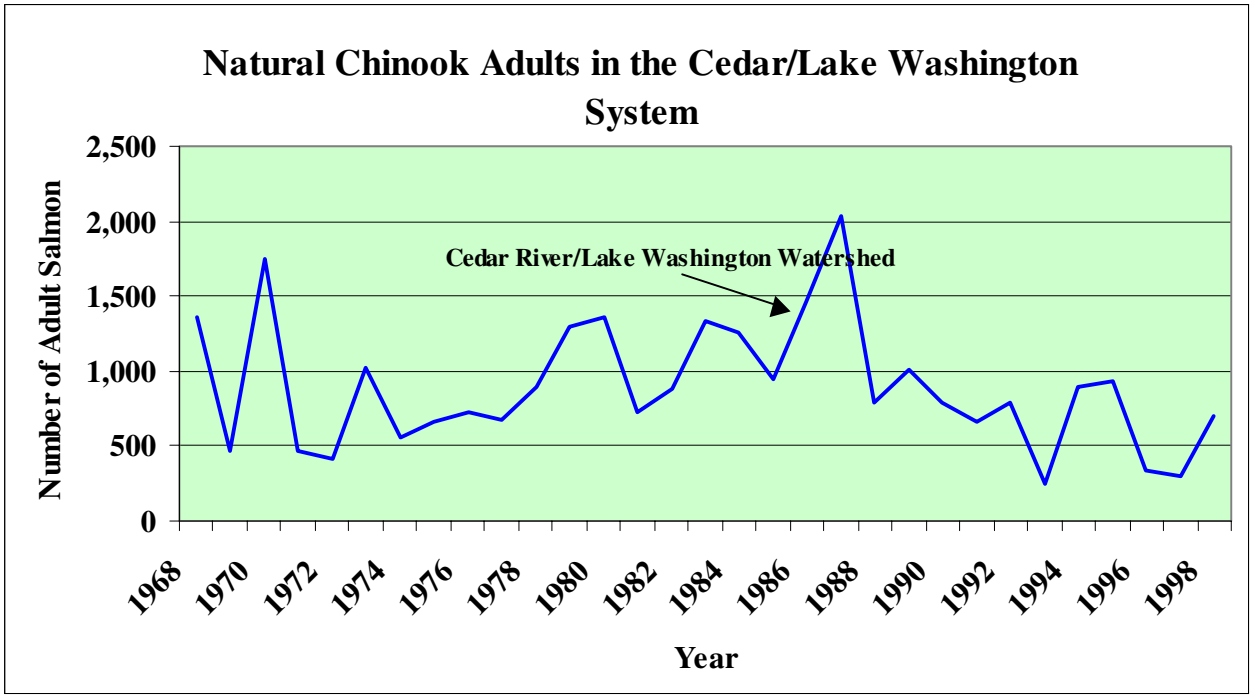
Data for this indicator will be available in the future.

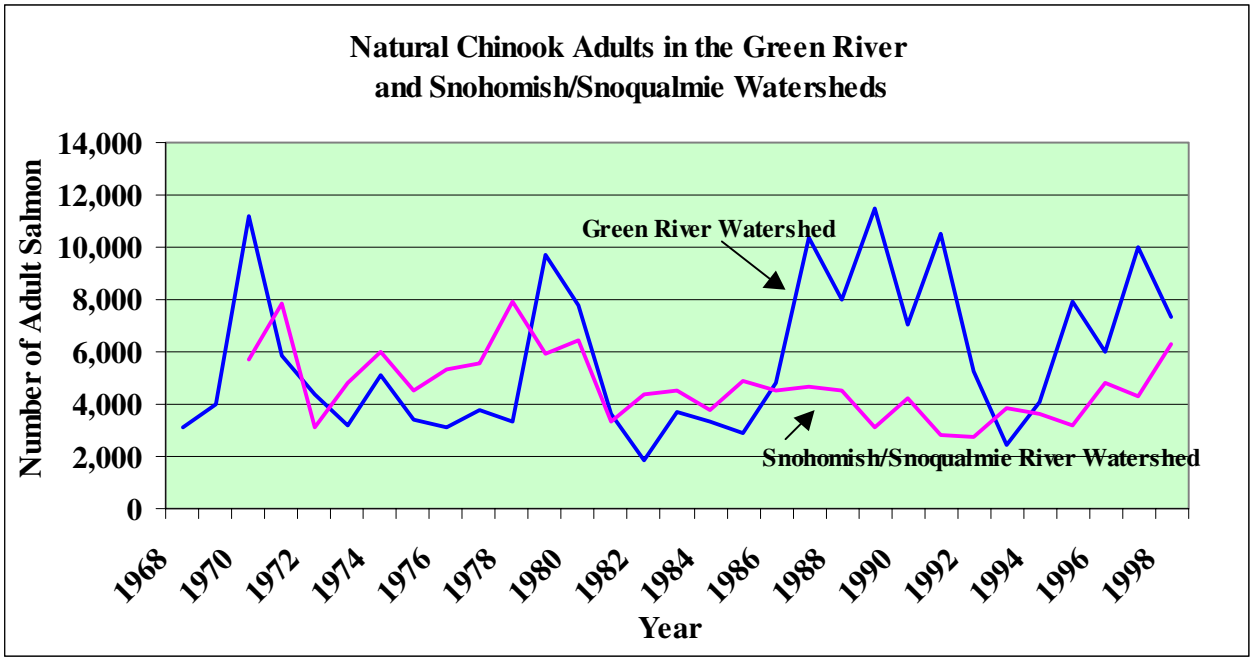
Policy Rationale: The policy rationale stems from Countywide Planning Policies CA-7 and CA-8. Obstacles/barriers such as roads and buildings can interfere with the intent of a continuous countywide habitat network. They interfere with a species' space requirement and its ability to seek adequate food, cover, and water. Any obstacles/barriers need adequate mitigation to reduce impacts to wildlife/fish species. Jurisdictions will promote wildlife protection and integrate native plant communities and wildlife with other land uses where possible, according to Countywide Planning Policy CA-7.

ENVIRONMENT INDICATORS

Outcome: Increase Salmon Stock

INDICATOR 18: Change in the number of salmon





INDICATOR 18:

ENVIRONMENT INDICATORS

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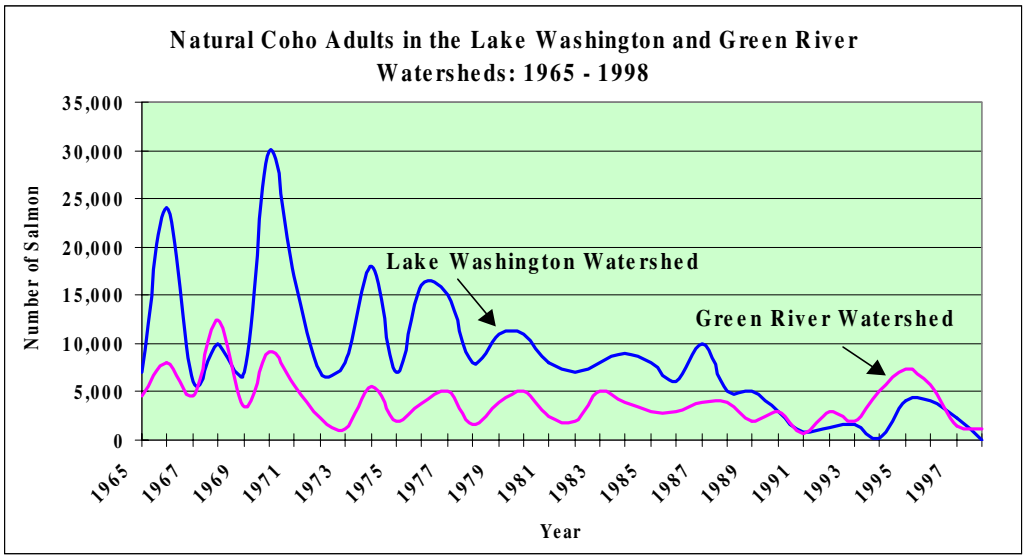

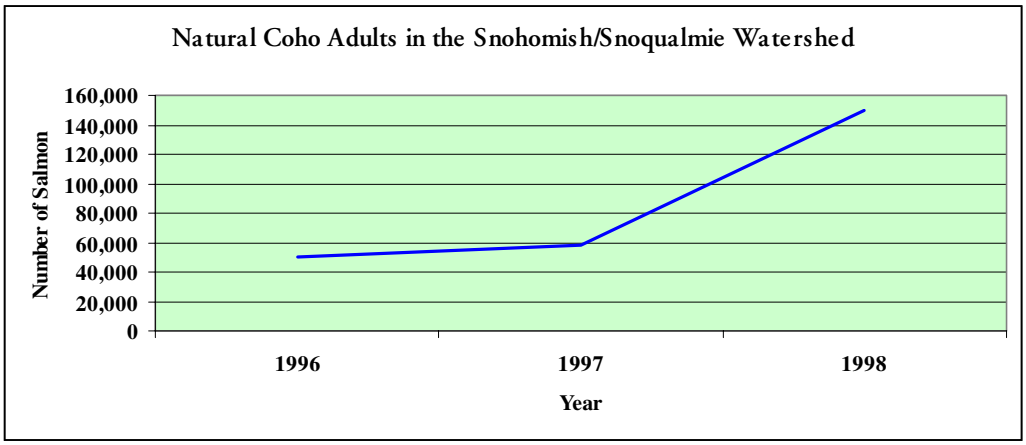

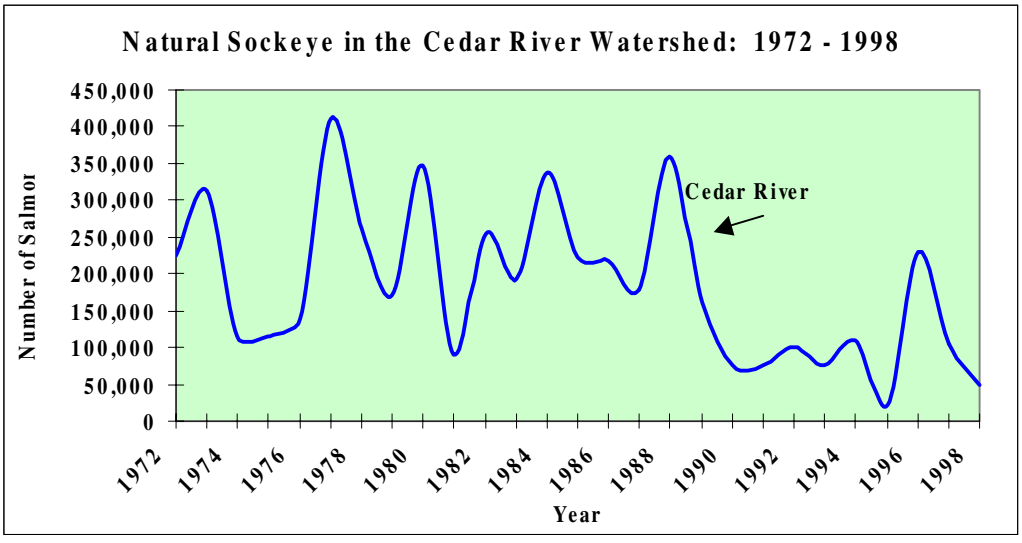

ENVIRONMENT INDICATORS

INDICATOR 18:

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Definitions:

- *For salmon and steelhead stocks, the term escapement refers to those mature fish that have returned to freshwater, have survived all fisheries and constitute the spawning population for a given stock. All data presented in the graphs are escapement data.*
- *A native stock is defined as an indigenous stock of fish that has not been substantially impacted by genetic interactions with non-native stocks, or by other factors and is still present in all or part of its original range. A non-native stock is one that has become established outside of its original range.*
- *A wild stock is one that is sustained by natural spawning and rearing in the natural habitat, regardless of parentage. A hatchery-raised stock depends upon spawning, incubation, hatching or rearing in a hatchery or other artificial production facility.*
- *The term natural fish refers to those fish that spawn naturally whether or not they originated in a hatchery or in the wild.*
- *According to the 1992 SASSI (Washington State Salmon and Steelhead Stock Inventory), a healthy stock is defined as a stock of fish that experiences production levels consistent with its available habitat and within the natural variations in survival for the stock. A depressed stock of fish exhibits production levels below expected levels. A critical stock of fish experiences production levels that are so low that permanent damage to the stock is likely or has occurred already. On stocks rated unknown there is insufficient information to rate the stock status, and an extinct stock is one that is no longer present in its original range or as a distinct stock elsewhere.*
- *The Lake Washington System is comprised of the Cedar River and its tributaries, Bear Creek, Issaquah Creek, Lake Sammamish and the Lake Washington and North Lake Washington tributaries.*
- *The Green River Watershed includes the Duwamish River and the Green River and its tributaries.*
- *The Snoqualmie-Snohomish Watershed includes the Skykomish, Snoqualmie, and Snohomish sub-basins and their tributaries. Over one-half of this watershed lies in King County.*

Observations:

<u>*General*</u>

- The five graphs depict large yearly variations in salmon returning to spawn in both native and non-native species. Some of that variation is due to natural variability unrelated to human influences. However, the decline in wild Chinook, Coho, and Sockeye stocks is considerably more enduring than would be expected from natural fluctuations. Habitat deterioration caused by urban and industrial growth, forest practices, agricultural practices, municipal, industrial and agricultural water diversions, and hydropower have all contributed to diminishing the abundance and diversity of salmon. In addition, resource management policies related to harvesting will impact many wild stocks.
- It is often very difficult to determine the relative importance of any single factor or combination of factors that can influence the status of a particular stock. Therefore this analysis will highlight observations regarding certain salmon species in watersheds within King County without attempting to link them to specific factors.
- The Puget Sound Basin provides habitat for a total of 209 salmon and steelhead stocks. According to the 1992 SASSI (Washington State Salmon and Steelhead Stock Inventory) assessment, 44% of these stock are rated healthy, 21% depressed, 5% critical, 29% unknown and 0.2% extinct.

<u>*Chinook*</u>

- In 1998 the listing of Puget Sound Chinook salmon as a threatened species under the Endangered Species Act was announced.

ENVIRONMENT INDICATORS

INDICATOR 18:

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- The total number of adult Chinook in the Lake Washington System has been quite low compared to other stocks since data collection began in 1968. The number fluctuated between a low of about 450 and a high of over 2000 through the 1970s and 1980s. However, 1993, 1996, and 1997 showed exceptional lows in the range of 250 - 350. In 1998, the number of adult Chinook rose to nearly 700. Nevertheless, the average of runs in the 1990s are about one-half the average during the 1980s.
- The number of Chinook in the Snohomish/Snoqualmie Watershed has shown a declining trend since the late 1970s, and wild Chinook is classified as depressed in the Snohomish basin. In 1998, however, adult Chinook returned to this watershed in their highest numbers – over 6,000 - since 1980.
- In 1992 Chinook salmon was classified as *healthy* in Issaquah Creek and *unknown* due to lack of consistent spawning ground data in the North Lake Washington tributaries and in the Cedar River. Chinook in the Green River Watershed is classified as healthy. However, there is considerable mixing of hatchery and wild fish in the Green River Watershed, making the count of natural spawning fish somewhat inflated over the actual number of wild fish.
- Flooding and the associated high flows in the region's rivers and streams during 1994 - 1996 caused considerable damage to spawning grounds and to the survival of salmon eggs. Chinook spawn in main-stem channels where flood damage is most severe. Low yields from spawning grounds in those years could be expected to lead to low escapement numbers in 1998 - 2000 when the four-year olds return to spawn as adults. In 1998, it appears that various other favorable conditions have moderated that effect.
- A tri-county effort is underway to develop a regional response to the proposed ESA listing of Chinook, and to find ways to improve conditions for Chinook survival.

Coho

- The graph above depicts Natural Coho in the Lake Washington System and the Green River Watershed. In 1970, a high of 30,000 fish was recorded in the Lake Washington System while a low of 200 was recorded in 1994. After three years of relatively good returns, there were less than 500 adult Coho that returned to the Lake Washington Watershed in 1998. The status of the stock was classified as *depressed* in Lake Washington and Sammamish tributaries and *healthy* in the Cedar River according to the 1992 SASSI assessment.
- Coho in the Green River Watershed show similar fluctuation. After fairly health returns in 1994 – 1996, the numbers have again fallen off in 1997 – 1998. With the exception of a severe low in 1991, the past two years have had the lowest returns since 1973.
- As with the Chinook, the presence of considerable numbers of hatchery fish in the Green River Watershed make accurate counts of wild fish difficult to achieve. Although methods for getting an accurate count of wild salmon have improved, it is likely that the Green River count of "natural" fish is higher than the actual presence of the wild stock.

Sockeye

- Sockeye in the Cedar River are considered wild and non-native. As the last graph above shows, escapement numbers exhibit considerable fluctuation with a downward trend since 1989. The status of Sockeye in the Cedar sub-basin is classified as depressed.
- Sockeye in Big Bear Creek and Issaquah Creek (Lake Washington/Sammamish tributaries) are considered a stock of unknown origin with wild production. According to the 1992 SASSI assessment, the stock status for salmon in both creeks was considered depressed. However, in Big Bear Creek, very high adult returns in 1992, 1994, and 1996 have alternated with historically low numbers, making it difficult to evaluate the status of Sockeye in that tributary. In 1998, there were

ENVIRONMENT INDICATORS

INDICATOR 18:

(continued from previous page)

- approximately 10,000 adult Sockeye returns in all of the Cedar River tributaries (other than the Cedar itself) and Lake Washington. This total is nearly 20% lower than the previous year.
- State and tribal fisheries managers are developing a Wild Stock Restoration Initiative (WSRI) in order to maintain and restore healthy wild salmon and steelhead stocks and their habitats.

Hatcheries

- The Washington Department of Fish and Wildlife operates hatcheries on the Cedar River, Issaquah Creek and Soos Creek in King County. The Muckleshoot Tribe operates hatcheries on Keta Creek and Crisp Creek. Hatcheries raise fish primarily for human consumption and serve an important role in protecting wild fish from being overharvested. In 1997, the Cedar River/Lake Washington Watershed hatcheries had adult returns of 18,975 Coho and 3,481 Chinook. The Green River Hatcheries, including Soos Creek, had 22,666 Coho return, and 11,800 Chinook return.

Data Sources: Washington Department of Fish and Wildlife; *1992 Washington State Salmon and Steelhead Stock Inventory (SASSI) - Appendix One, Puget Sound Stocks, South Puget Sound Volume.,* Washington Department of Fisheries, Washington Department of Wildlife and Western Washington Treaty Indian Tribes.

Policy Rationale: The policy rationale stems from Countywide Planning Policies FW-4, FW-5, CA-8, CA-9, CA-10, CA-11 and CA-15. Salmon are a symbol of the Pacific Northwest. They have important recreational, economic, cultural and environmental values for residents of King County. The health of salmon populations is an Indicator of environmental quality because these populations are affected by land use policies and actions within the watershed. The status of salmon populations indicate the overall health of rivers, lakes and streams, because salmon are very sensitive to deterioration in water quality, sediment and temperature changes and changes in the flow regime.

ENVIRONMENT INDICATORS

INDICATOR 18:

(continued from previous page)

Indicator 18: Background Information

	Natural Coho				Natural Chinook				Natural Sockeye				
Year	Lake Washington Watershed	Green River Watershed	Snohomish/ Snoqualmie River Watershed*		Lake Washington System	Green River Watershed	Snoqualmie River Watershed		Cedar River	Big Bear Creek	Issaquah Creek	Cottage Creek	Lake WA Beaches & Other
1965	7,000	4,600											
1966	24,000	8,000											
1967	6,000	4,600											
1968	10,000	12,500			1,363	3,110							
1969	7,000	3,400			466	4,035							
1970	30,000	9,100			1,745	11,171	5,724						
1971	17,000	5,700			471	5,832	7,824						
1972	7,000	2,300			419	4,343	3,128		225,862				
1973	8,000	1,100			1,025	3,180	4,841		314,194				
1974	18,000	5,600			560	5,095	6,030		114,472				
1975	7,000	1,900			656	3,394	4,485		114,106				
1976	16,000	3,700			719	3,140	5,315		138,949				
1977	15,000	5,100			675	3,804	5,565		410,020				
1978	8,000	1,700			890	3,304	7,931		262,733				
1979	11,000	4,000			1,289	9,704	5,903		172,300				
1980	11,000	5,000			1,360	7,743	6,460		347,827				
1981	8,000	2,500			721	3,606	3,368		90,694				
1982	7,000	2,000			885	1,840	4,379		253,658	17,871	9,842		
1983	8,000	5,000			1,332	3,679	4,549		193,338	20,720	2,937		
1984	9,000	4,000			1,252	3,353	3,762		336,960	21,335	2,437		
1985	8,000	3,000			949	2,908	4,873		223,745	20,160	2,054		
1986	6,000	3,000			1,470	4,792	4,534		217,133	22,982	2,491		
1987	10,000	4,000			2,038	10,338	4,689		177,841	18,844	1,000		
1988	5,000	4,000			792	7,994	4,513		359,000	8,779	5,536		
1989	5,000	2,000			1,011	11,512	3,138		162,000	1,795	1,306		
1990	3,000	3,000			787	7,035	4,209		76,000	10,115	707		
1991	800	700			661	10,548	2,783		77,000	7,691	1,588		
1992	1,300	3,000			790	5,267	2,708		100,000	27,533	23,979		
1993	1,600	2,000			245	2,476	3,866		76,000	9,848	3,351		
1994	200	5,000			888	4,078	3,626		109,000	39,645	700		
1995	4,100	7,400			930	7,939	3,176		22,000	2,329	385	382	1,100
1996	4,127	5,701	50,000		336	6,026	4,851		230,000	51,518	2,278	6,117	12,580
1997	2,300	1,500	58,200		294	6,949	4,272		104,000	6,714	2,832	882	1,580
1998	<500	1,200	150,000		697	7,312	6,300		50,000	10,000*			

Data for the Snohomish-Snoqualmie basin were not collected for this report until 1998. Only the Snoqualmie portion, and parts of the Skykomish portion, of the Snohomish Watershed lie within King County.

* This number represents the total in the Cedar River tributaries, other than the Cedar River itself.

ENVIRONMENT INDICATORS

Outcome: *Decrease Noise Levels*

INDICATOR 19: Rate of increase in noise from vehicles, planes and yard equipment.

Day-Night Average Sound Levels (DNL) at SeaTac Monitoring Stations: 1990 - 1998					
Monitoring Location	**Nov. 1990***	**Nov. 1993***	**Nov. 1995***	**Nov. 1997***	**Nov. 1998***
Parkside School - S. 247th St. Des Moines	73.2	69.7	69.4	69.1	68.7
13th Ave. S. and S. 120th St.	74.4	72.1	70.5	68.9	69.7
Glendale School - S. 104th St. & 13th Ave S.	70.8	na	64.0	na	67.9
***All numbers are average DNL's for the preceding 12 months, except the Glendale site in '98 which is an average of the preceding 7 months.**					

Day-Night Average Sound Levels (LDNA) at King County Intl. Airport Monitoring Stations: 1997 - 1998					
Monitoring Locations	**2nd Qtr. 1997**	**4th Qtr. 1997**	**2nd Qtr. 1998**	**4th Qtr. 1998**	**1st Qtr. 1999**
Ruby Chow Park School	71.7	70.1	69.9	69.6	69.0
Duwamish Park - 44th Ave. S.	na	67.7	67.0	67.8	67.3
***Numbers are average LDNA for the quarter.**					

Definitions:

- ***Day-Night Average Sound Level (DNL, previously known as Ldn)*** *is a noise measure used to describe the average noise exposure levels over a 24-hour period, typically an average day over the course of the year. It is based on an A-weighted (dBA) sound level scale* (see below)***.*** *It considers aircraft operations that occur between the hours of 10 PM and 7 AM to be 10 decibels louder than they actually are to account for increased annoyance. DNL is currently the accepted measure for aircraft noise analysis. Generally a DNL of 65 or greater is considered significant noise exposure,while a DNL of 75 or greater is considered severe noise exposure.*
- ***DNL (or Ldn)*** *is also subdivided into aircraft only* ***(LDNA)*** *and community* ***(LDNC)*** *levels.*
- ***A-Weighted Sound (dBA)*** *is a measurement representing a sound generally as the human ear hears it, by filtering out as much as 20 to 40 decibels of sound below 100 hertz (Hz). It is used for evaluation of most community noise levels and impacts, as well as aircraft noise evaluations.*
- ***Noise Contour*** *lines connect geographic points with the same average annual noise exposure. Noise contour maps have been generated to show the areas affected by Day-Night Average Sound Levels (DNL or ldn) of 60, 65, 70, and 75 in the region around Sea-Tac Airport.*
- ***Equivalent Sound Level (L Eq)*** *is the constant sound level that, in a given situation and time period, conveys the same sound energy as the actual time-varying A-weighted sound. The time period applicable must be specified.*
- *The Federal Aviation Administration certifies aircraft by noise levels. Stage 1 aircraft, the oldest and noisiest (e.g. B707) have been phased out of the fleet of aircraft operating in the U.S.*

ENVIRONMENT INDICATORS

INDICATOR 19:

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- *Stage 2 jet aircraft include models such as the Boeing 727, Boeing 737-200 and DC9. Stage 3 jets, the quietest in operation today, include the Boeing 757, Boeing 777, DC10 and others. Stage 3 jets also include aircraft that were Stage 2 when manufactured, but have since been hushkitted or re-engined to meet Stage 3 noise standards.*

Observations:

General

- High noise exposure is linked to hearing loss, sleep deprivation and other stress related health concerns.
- More than four straight hours of exposure to noise levels between 80 and 110 decibels causes permanent damage that could eventually lead to significant hearing loss.
- There are a number of sources of excess noise exposure in the community. Among the most significant are construction activity noise, traffic noise, transit vehicle noise, and poorly muffled yard and commercial
  maintenance equipment. Examples of approximate noise readings for typical urban occurences are a jackhammer at 100 decibels or a fire engine at 103 decibels. The variability and randomness of many noise incidences make quantitative assessment of their individual contributions to community noise exposure exceedingly difficult.
- This report includes limited information about ongoing noise monitoring activities at Seattle, King County International Airport and Sea-Tac Airport. There is no source of comprehensive data available for other types of community noise.

Sea-Tac Airport

- Based on its Noise Monitoring System, the DNL values at SeaTac have decreased from an average of 71 – 73 since the early 1990's when a mediation agreement was developed to reduce overall noise, to 68 – 70 in 1998. By comparing the DNL values, it appears that the noise energy has decreased even though the number of departures and arrivals has increased. This decrease can be attributed to the increase in the number of quieter Stage 3 aircraft at the airport, and the decrease in the number of noisier Stage 2 aircraft.
- The Federal government is phasing out the use of Stage 2 aircraft in the U.S. with a deadline of Jan. 1, 2000.
- The Port of Seattle has stricter local rules than the federal rules, and restricts use of Stage 2 jets between the hours of 10:00 p.m. and 7:00 a.m.
- The Port of Seattle's Noise Budget Program has helped to phase out the Stage 2 jets sooner than the federal schedule. Of the Stage 2 jets covered by the phase out regulations, only 5% remain in operation at Sea-Tac.

King County International Airport (KCIA)

- LDNA values at KC IA have decreased slightly over the last two years.
- In June 1998, new legislation was approved by the King County Council and Executive to protect airport neighbors from aircraft noise. Under the legislation, the county will spend $5.5 million for the design and eventual construction of a "hush house" (insulated hanger) to reduce engine testing noise. Additional highlights of this new effort are that it:
  - Directs the KCIA to begin an EIS, a land use compatibility study, and a noise remedy study;
  - Directs the KCIA to prepare and submit to the Council an extensive noise reduction program;
  - Appropriates $500,000 for additional master planning work, following approval of the final work plan;
  - Calls for the development of a noise insulation program to help abate noise;
  - Requires that long-term leases at the airport provide for periodic review of compliance with relevant noise reduction regulations and policies.

ENVIRONMENT INDICATORS

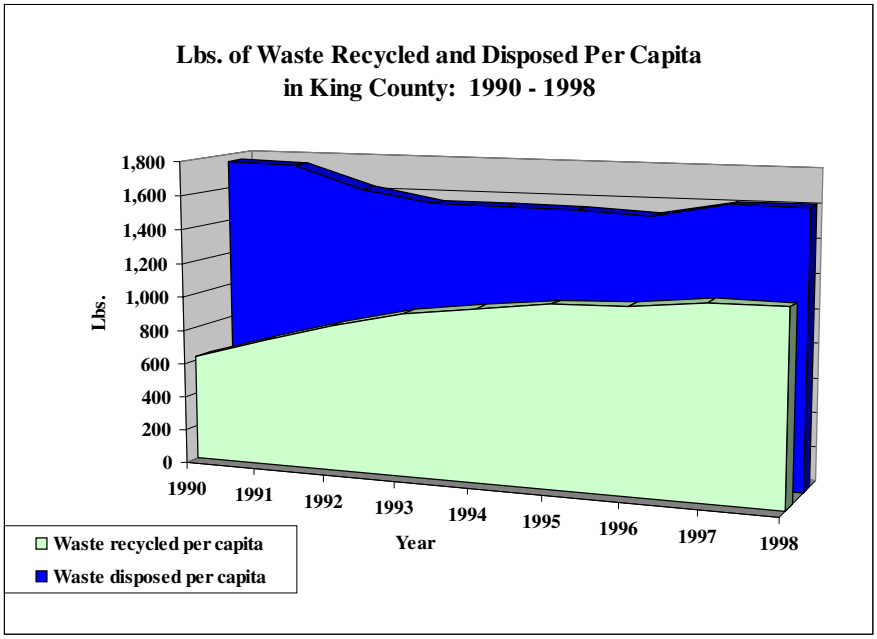
Data Source: Seattle Department of Construction and Land Use: King County International Airport; Sea-Tac International Airport Community Program.

Policy Rationale: Although the Countywide Planning Policies do not contain specific policy direction for noise, the Benchmark Task Force added this Indicator because there were concerns about noise levels in King County. The Task Force also wanted to monitor how noise levels were affected by growth management issues.

ENVIRONMENT INDICATORS

Outcome: *Decrease Waste Disposal and Increase Recycling*

INDICATOR 20: Pounds of waste disposed and recycled per capita.



Definitions:

- *All figures are estimates.*
- *Waste disposed includes residential and commercial waste.*
- *Total waste disposal figures exclude construction and land clearing debris, which was banned from the King County system in September 1993. Special waste figures are also excluded.*
- *Recycling figures exclude ferrous metals.*

Observations:

- Waste recycled per capita in 1998 remained nearly the same as in 1997. The per capita amount recycled steadily increased from 1990 - 1997 at an annualized growth rate of 8.2%. However, the 1997 - 1998 recycling estimates for King County show a leveling off in the amount recycled per person.

ENVIRONMENT INDICATORS

INDICATOR 20:

Pounds of Waste Per Capita Disposed and Recycled in King County by Year									
Year	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**
Recycled Per Capita	622	748	859	959	1,032	1,093	1,086	1,120	1,119
Waste Disposed Per Capita	1,757	1,746	1,619	1,552	1,540	1,543	1,536	1,609	1,608
Total Waste Generated Per Capita	2,379	2,493	2,479	2,511	2,572	2,635	2,623	2,729	2,727

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- Solid waste disposal per capita decreased from 1990-1996 at an annualized rate of 2.2%. Between 1996 and 1997, however, disposal per capita showed a marginal increase, before leveling off again in 1998. A strong economy coupled with spill-over effects of a 1996 year end storm may have contributed to increased disposal in 1997.
- While solid waste disposal per capita has decreased since 1990, total waste generated per capita (the sum of disposal per capita and recycling per capita) has increased by nearly 350 lbs. per person over the 8 year period, or approximately 1.8% per year. Seattle and King County serve as employment and population centers for the region. The relatively high level of economic activity and the large number of individuals working in the region may be responsible for this increase in waste generation per capita.
- While the eight year trend has been toward a higher amount of waste generated per capita, 1998 actually brought a decline of two pounds per person in the amount generated when compared to the 1997 amount.

Data Sources: Solid Waste Division, King County Department of Natural Resources: Resource Planning division; Seattle Public Utilities Department.

Policy Rationale: Although the Countywide Planning Policies do not include policy direction for reducing solid waste or promoting recycling programs, the Benchmark Task Force added this Indicator, because recycling and reductions in solid waste save resources, save landfill space and reduce the potential for soil and water contamination due to leakage from landfills.